

# **NASA Astronaut Urinary Conditions Associated with Spaceflight**

<b>Richard Cole, M.D., M.P.H., F.A.C.E.P</b>	University of Texas Medical Branch University of Texas at Houston Medical School
<b>Jennifer Law, M.D., M.P.H.</b>	NASA Johnson Space Center
<b>Sara Mason, B.S.</b>	MEI Technology
<b>Millennia Young, Ph.D.</b>	Wyle Science, Technology, and Engineering

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# Disclosures

- We have no financial relationships to disclose.
- We will not discuss off-label use or investigational use in this presentation.

# Introduction

- Spaceflight is associated with many factors which may promote urinary retention, urinary tract infection, kidney stone formation
  - Obstructive (anatomical) – e.g., BPH
  - Psychosocial
  - Gravitational
  - Pharmacologic
  - Neurogenic (SAS-Related)
  - Infectious (UTI)
- Urinary conditions are among the top 3 conditions predicted by NASA's Integrated Medical Model as the most likely reason for emergent medical evacuation from ISS
  - Kidney stone: #2
  - Sepsis (urosepsis as primary driver): #3

# Methods

- Inflight and post-flight medical records of NASA astronauts were reviewed for urinary retention, urinary tract infection, and kidney stones during Mercury, Gemini, Apollo, Mir, Shuttle, and ISS Expeditions 1-38

# Results – Kidney Stones

- No inflight occurrence of kidney stones
- 7 events(N=6) of kidney stones developed in the 12 months after flight
  - One case in the first 90 days after flight
  - Three cases occurred within 90 to 180 days after landing

# Results – Urinary Retention

- 9 cases of urinary retention documented
- 16 total if symptoms suggestive of urinary retention are included (0.018 events per person-mission)

	Shuttle	ISS	Catheter Required	EVA Related	SMS Med Usage
Urinary Retention	8	1	4	1	7
Bladder fullness/pressure	2	0	0	0	1
Difficulty initiating/hesitancy	5	0	0	1	4
TOTAL	15	1	4	2	12

Urinary Retention	Incidence Rates
Shuttle	0.019 events/person mission
ISS	0.021 events/person mission

	<u>N</u>	<u>Average Age (±SD)</u>
Total	16	43.44 (6.62)
M	9	46.00 (7.50)
F	7	40.14 (3.48)

# Contributing Factors

- Incidence of space motion sickness (SMS) starting with Apollo range from 35-80%. <sup>1-4</sup>Anticholinergics are a common treatment for SMS; i.e., Promethazine, Scopolamine, Meclizine (both prophylactic and active treatment)
- Decongestants/Antihistamines are frequently used for treatment on ISS, prophylactically for EVAs and for active treatment of upper respiratory infections/allergic rhinitis<sup>5</sup>
- Urinary retention is a known side effect of anticholinergics/anticholinergic-like medication

<sup>1</sup>Nicogossian et al Space Physiology and Medicine 3<sup>rd</sup> ed, <sup>2</sup>Reschke et al Space Biology and Medicine , <sup>3</sup>Davis et al ASEM March 1993, <sup>4</sup>Jennings J Vestib Res 1998,

<sup>5</sup>Wotring FASEB J. 2015

# Results – Urinary Retention

Odds of developing urinary retention are 3 times higher among astronauts who took promethazine.

<b>P&lt;0.0001<sup>1,2</sup></b>	Incidence Rate	95% Confidence Limits	
<b>Promethazine</b>	0.032	0.0165	0.0612
<b>None</b>	0.0108	0.0044	0.0265

Females are 4 times more likely to develop urinary retention than males

<b>P=0.0161<sup>1,2</sup></b>	Incidence Rate	95% Confidence Limits	
<b>Males</b>	0.0128	0.0058	0.0280
<b>Females</b>	0.0546	0.0226	0.01261

<sup>1</sup>Based on Shuttle US and IP crewmembers and ISS US crewmembers

<sup>2</sup>Adjusted for repeated individuals



# Results – Urinary Tract Infection

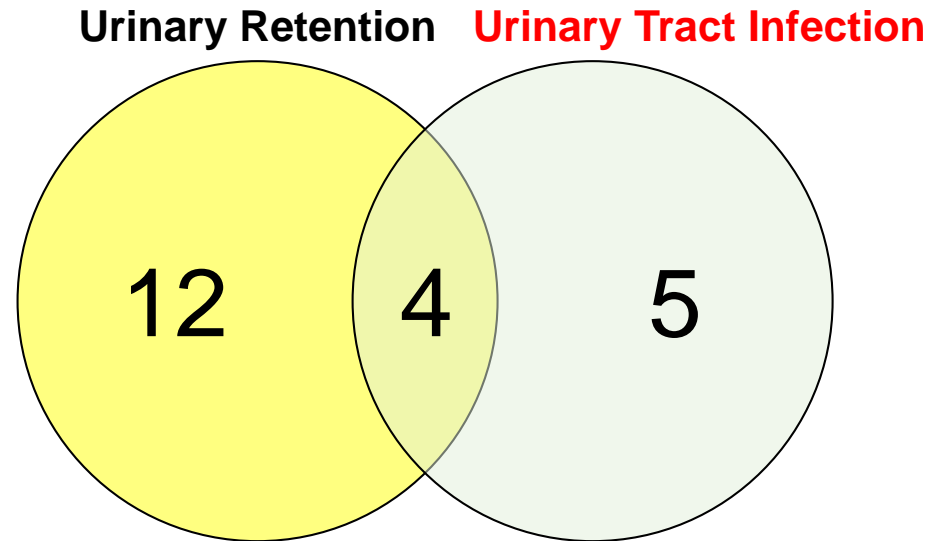
- All Shuttle crewmembers and/ ISS US crewmembers: 9 cases
  - Male: 1 event
  - Female: 8 events (5 crewmembers)
- Other publically known events of UTI in males in space flight
  - Apollo
  - Early Russian Mir

# Urinary Tract Infection

- Report of two Shuttle flights of a crewmember with positive urine culture for *Escherichia coli* at landing
  - Both cases had bladder catheterizations inflight
  - First case prophylaxed with antibiotics at time of bladder cath
    - Switched to TMP/SMX DS after exhausted supply of nitrofurantoin
    - Ground culture later found to be resistant to TMP/SMX DS
  - Second case received antibiotic prophylaxis and still had bacteriuria at landing

Stepaniak PC, Ramchandani, SR, Jones, JA. Acute Urinary Retention Among Astronauts. *Aviation, Space, and Environmental Medicine*. April 2007;78,4: A5-8

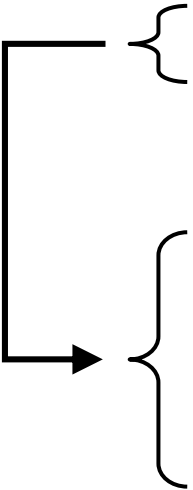
# Urinary Retention and Urinary Tract Infection



	Events	N=
Only Urinary Retention	12	10
Only Urinary Tract Infection	5	5
Urinary Retention + Urinary Tract Infection	4	3
Total Events	21	15

# Urinary Retention and UTI

- An astronaut with urinary retention is **25x** more likely to have a UTI
  - **17% infection rate**
  - Urinary retention vs. UTI - which is the chicken and which is the egg?



<b>P&lt;0.0001</b>	Infection Rate	95% Confidence Limits	
<b>Retention</b>	<b>0.1679</b>	0.0619	0.3818
<b>No retention</b>	<b>0.0067</b>	0.0028	0.0159

Based on all crew

<b>P=0.4412</b>	Infection Rate	95% Confidence Limits	
<b>Cath</b>	<b>0.4218</b>	0.0178	0.9670
<b>No cath</b>	<b>0.1746</b>	0.0149	0.7472

- An astronaut with a bladder cath is **2.5x** more likely to have a UTI (not statistically significant; not enough cases to have adequate power)
  - **42% infection rate**
  - Includes cases that prophylaxed with antibiotics

# Discussion

- It is unclear if spaceflight carries an increased postflight risk of kidney stones.
- Urinary retention
  - Female to male odds ratio is higher inflight compared to the general population where older males comprise almost all cases due to prostatic hypertrophy
  - The higher prevalence in females is even more concerning given the fact that there have been many more males in space than females
- Promethazine use increases the risk of developing urinary retention in spaceflight
- Urinary retention and urinary tract infection are highly associated
  - Both with or without bladder catheterization, but catheterization further increases risk of infection

# So What?

- Urinary retention is a bigger issue than previously thought
- Standard treatment for urinary retention (cath) increases risk of UTI
  - Aseptic techniques can be especially challenging with an inexperienced provider in a free-floating environment
  - Consider using touch free catheter systems to reduce infections
- UTIs treated with antibiotics
  - Medication supplies can become depleted
  - Exploration mission shelf life issues and potentially decreased antibiotic effectiveness
  - Potential for bacterial resistance
  - Theoretical increased pathogen virulence
  - Altered immune function
  - Inadequately treated UTI may lead to pyelonephritis and sepsis → evacuation or mission impact
- **Inflight urinary retention and UTI have proven to be associated and their risks should be considered collectively when planning for spaceflight.**

# Backup

# Terrestrial Data on Urinary Retention

- Urinary retention in men becomes more common with age.
  - In men 40 to 83 years old, the overall incidence of urinary retention is 4.5 to 6.8 per 1,000 men.
  - For men in their 70s, the overall incidence increases to 100 per 1,000 men.
  - For men in their 80s, the incidence of acute urinary retention is 300 per 1,000 men.
- Urinary retention in women is less common, though not rare.
- The incidence of urinary retention in women has not been well studied because researchers have primarily thought of urinary retention as a male problem related to the prostate.

NIH, <http://www.niddk.nih.gov/health-information/health-topics/urologic-disease/urinary-retention/Pages/facts.aspx>